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THE ANTHELMINTIC TREATMENT OF EQUINE INTESTINAL STRONGYLIDOSIS.[1]

By MAURICE C. HALL, Ph.D., D.V.M.; ROBERT H. WILSON, D.V.M.; and MEYER WIGDOR, M.A.

(Biological and Research Laboratories, Parke, Davis & Co., Detroit, Michigan.)

STRONGYLES, including for the most part species of the genus strongylus (sclerostomum) and cylicostomum (Trichonema, Cylicostomum, "Sclerostomum tetracanthum"), are very common parasites of the large intestine of the horse, and are regarded as rather serious parasites. The adult worms of the genus strongylus are blood-suckers, as their red colour indicates; and the habit of sucking blood produces here, as elsewhere, resultant anæmic conditions and the associated lowering of vitality and of resistance to other injurious factors. The larval worms develop in various organs and tissues outside of the digestive tract and in the walls of the digestive tract, acting as foreign bodies and occasioning varying degrees of injury according to location. The larvæ of Strongylus vulgaris cause aneurisms of the great mesenteric artery, and later pass, as agamic adults, to the walls of the cæcum, where they form small cysts or abscesses. The larvæ of Strongylus equinus usually occur in the liver, lungs, and pancreas. The larvæ of Strongylus edentatus are especially apt to occur under the serous membranes, the peritoneum and pleura, but may occur almost anywhere. The larvæ of cylicostomum occur in cysts in the walls of the large intestine. Verminous aneurisms are well known to veterinarians as the potential cause of sudden death by rupture, of intermittent lameness from embolism due to particles from the aneurism lodging in the blood vessels of the hind legs, and of verminous colic from embolism similarly occasioned occurring in the blood supply of the large intestine.

The symptoms resulting from infestation with these worms are diarrhœa, loss of appetite, emaciation, and anæmia. Later the animal may show œdema, joint infection, intermittent colic, or the

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other symptons noted. The condition, like almost all worm diseases, is afebrile. The disease may prove fatal, become chronic as the result of injuries to tissues, or the animal may recover.

The noted French authority, Railliet (1915), states that it is difficult to expel parasites from the large intestine by oral medication in any host species, and this is the general view of parasitologists and veterinarians. It is quite decidedly the prevailing view as regards the expulsion of strongyles from the horse. Here the worms are remote from the mouth and associated with large masses of undigested material in a way that makes dilution of the anthelmintic certain and contact with the worms theoretically difficult. Somewhat to our surprise, our experiments showed that these worms could be removed with great certainty and with a high degree of efficacy as regards the number removed compared with the total number present. Inasmuch as our findings in these experiments are completed by *post-mortem* examination, these results are dependable. Of course, occasionally failures must be expected, but strongylidosis is more susceptible of successful treatment than has been thought.

Our explanation of the high degree of efficacy obtained in the removal of worms from the cæcum and colon of the horse is that it is due to the increase in the time factor, as regards period of exposure of the worm to the anthelmintic. Anthelmintic efficacy is a product of certain factors—the potency of the drug, the amount of the drug, the contact with the worms, and the period of contact with the worms. In a general way, an increase in any of these factors increases their product, which is the anthelmintic efficacy. Food and drugs pass rather rapidly from the stomach and through the small intestine of the horse, but they lie for comparatively long periods in the cæcum and double colon. It seems entirely probable that the long period in which anthelmintics may operate in the large intestine is responsible for the high efficacy they attain. In this connection it should be noted that food enters the cæcum of the horse through one aperture and passes out through another, a condition not present in such animals as the chicken, dog, swine, sheep, cattle, etc. In the latter animals, it is theoretically possible, and, in the case of the dog, entirely probable from the evidence of such anthelmintic experiments as those of Hall and Foster (1918), for drugs to pass the ileocolic or ileocæcal valve to the colon without entering the cæcum. This is not possible in the horse, so that drugs can be depended on to enter the cæcum if they pass the ileocæcal valve.

The method used by us in our experiments was the one already published by one of us (Hall, 1917) in connection with a study of the action of carbon bisulphide on bots. One of us (Wilson) administered the drugs, supervised the feeding and fasting of the horses and the collection of the manure and made the general *post-mortem* examination. The others made daily collections and identifications of the worms from the manure, collected and identified the worms present *post-mortem*, and noted the condition of the digestive tract *post-mortem*. Worms were only identified as far as their genus, it being out of the question to identify species of Cylicostomum trichonema from manure in work of this sort and

unnecessary to do this or identify species of strongylus in ascertaining efficacy. Our results do not indicate that any particular species shows any special resistance. The manure was examined daily, being picked apart slowly and carefully. This is a slow and tedious task, but entirely feasible. A few cylicostomum are doubtless overlooked, but the oversights *ante-mortem* and *post-mortem* probably offset one another, leaving the ascertained percentage of anthelmintic efficacy substantially correct. Rubber gloves were worn to protect the hands, but the task of examining manure thus is not so unpleasant as might be imagined. On *post-mortem* examination, the contents of the large intestine were examined in the same way, and the worms collected, counted, and identified.

Railliet (1915) notes that Giles gave a pony thymol to remove cylicostomum, using three doses of 15 grammes each, which removed many worms. Subsequently he gave the same animal a lavage with a watery emulsion of 45 grammes of thymol dissolved in alcohol. This killed the worms and the horse. Railliet also notes that Theobald gave a horse thymol, 1 gramme in the morning and 1 gramme in the evening, the dose being dissolved in 30 grammes of alcohol. The next day he gave castor oil. Theobald claims that this killed strongyles, ascarids and pinworms, and even killed the encysted forms. Railliet further notes that Dorn and Bochberg used atoxyl, the former injecting 3 grammes in 100 grammes of water at 37° C., and the latter injecting ·2 to 1·5 grammes in 1 per cent. saline solution intravenously and subcutaneously. Leneveu (1915) recommends the use of carbon bisulphide in gelatine capsules, giving 2 to 5 grammes, according to the size of the animal, every day for five days, and following this on the sixth day with a purgative, preferably magnesium sulphate. Conreur (1915) gives one- to two-year-old colts a hard soap bolus containing 6 grammes of thymol, a ½ gramme of santonin, and 6 grammes of aloes. One bolus is given every two to four days for a total of three or four doses. The dose is doubled for a three-year old.

In our experiments, some of the common anthelmintics which are given to horses for worms, usually for ascarids, were tested. These anthelmintics were iron sulphate, tartar emetic, and turpentine. In addition we tested oil of chenopodium, which has been recommended for worms in horses by Thum (1915) and by Wooldridge (1916). Thum gives suckling foals three doses at two-hour intervals for a total of 50 drops, followed two hours later by castor oil if desired, and gives 50 to 100 drops to colts which are weaned. He thinks it is much safer than tartar emetic. Wooldridge gave a horse 1 drachm of oil of chenopodium and 40 grains of thymol twice a day for a month and reports that the animal passed myriads of worms and became fat. The dosage used and recommended for the other drugs named varies considerably. Iron sulphate is given in doses of 1 oz. to the fasting animal, in 2- to 4-drachm doses in a mash, twice a day for seven days. Tartar emetic is given in doses of 1 oz. in aloes ball to the fasting animal, 2 to 4 drachms in a mash twice a day for five days, etc. Turpentine is usually given in doses of 1 to 4 ozs. in a half pint to a quart of linseed oil. Place (1915) says of turpentine: "One or two teaspoons of chloroform increases the effectiveness of the mixture and the risk."

Our experiments were as follows:—

Horse No. 1640, a fourteen-year-old gelding weighing 1075 lbs., was given 2 drachms of iron sulphate in a mash daily for seven days. The third day of treatment the horse passed two cylicostomum, the fourth day one, and the sixth day one, a total of four cylicostomum. The horse was killed ten days after the last treatment, the manure being examined during this period following treatment. On *post-mortem* examination the animal had 288 cylicostomum and 80 strongylus. The treatment was 0 per cent. effective against strongylus and much less than 1 per cent. effective against cylicostomum; in other words, a failure.

Horse No. 32, an eleven-year-old gelding weighing 1250 lbs., was given 2 drachms of tartar emetic in a mash daily for five days. The third day the horse passed one cylicostomum, the fourth day one, the first day after the last treatment two, the third day 4 cylicostomum and one strongylus, the seventh day one cylicostomum, and the twelfth day one, a total of ten cylicostomum and one strongylus. On *post-mortem* the horse had 5474 cylicostomum and 312 strongylus. The treatment was therefore less than 1 per cent. effective against cylicostomum and strongylus; in other words, a failure. The small intestine showed numerous petechiæ and ecchymoses which were apparently due to the action of the drug.

Horse No. 371, a nine-year-old gelding weighing 1050 lbs., was given 2 ozs. of turpentine, followed immediately by a quart of linseed oil. The next day the horse passed 9 strongylus and 56 cylicostomum, the second day 50 strongylus and 211 cylicostomum the third day 18 strongylus and 3 cylicostomum, the fourth day 3 strongylus, the fifth day 22 strongylus, the sixth day 3 cylicostomum, a total of 102 strongylus and 274 cylicostomum. The seventh day the animal passed no worms and was killed. On *post-mortem* examination the horse had 105 strongylus in the cæcum and 7 in the colon, a total of 112; no cylicostomum was found. The treatment was therefore 100 per cent. effective against cylicostomum and 48 per cent. effective against strongylus, a very good showing. This horse had been fasted less than twenty-four hours, and it is possible that greater efficacy would have resulted from a longer period of fasting.

Horse No. 1641, a thirteen-year-old mare weighing 1100 lbs., was given 8 mils of oil of chenopodium, followed immediately by a quart of linseed oil. The third day after treatment the horse passed 1 cylicostomum, the fourth day 1 cylicostomum, and the sixth day 1 strongylus and 430 cylicostomum. The treatment was therefore less than 1 per cent. effective against strongyles; in other words, a failure. This horse had been fasted less than twenty-four hours.

Horse No. 89, an eleven-year-old gelding weighing 1070 lbs., was given 10 mils of chenopodium, a somewhat larger dose than in the previous case, followed immediately by a quart of linseed oil. The second day the horse passed 5 strongylus and 169 cylicostomum, and the third day 2 cylicostomum. The horse was killed the third day. On *post-mortem* examination, 16 cylicostomum were found dead and being passed out in the floating colon, making a total of 187 cylicostomum to be credited to the anthelmintic. There were still left 1545 strongylus and 448 cylicostomum. The treatment was

therefore less than 1 per cent. effective against strongylus and was 29 per cent. effective against cylicostomum. The horse had been fasted less than twenty-four hours and was inadvertently fed shortly before treatment.

Horse No. 272, an eleven-year-old gelding weighing 1150 lbs., was given 16 mils of chenopodium, double the dose given to No. 1641, followed immediately by a quart of linseed oil. The next day the horse passed 4 strongylus and 17 cylicostomum, the second day 7 strongylus and 15 cylicostomum, the third day 39 strongylus and 70 cylicostomum. The horse was killed on the fourth day and found to have 19 strongylus. The treatment was therefore 100 per cent. effective against cylicostomum and 76 per cent. effective against strongylus. The horse was fasted less than twenty-four hours before treatment.

Horse No. 273, an eleven-year-old gelding weighing 1100 lbs., was given 18 mils of chenopodium, followed immediately by a quart of linseed oil. The next day the horse passed 64 cylicostomum, the second day 293 cylicostomum and 7 strongylus, and the third day 64 cylicostomum and 1 strongylus, a total of 421 cylicostomum and 8 strongylus. On *post-mortem* examination the horse had 7 cylicostomum and 1 strongylus in the floating colon, which should be credited to the efficacy of the anthelmintic. There were also 102 strongylus and 3195 cylicostomum. The treatment was therefore 11 per cent. effective against cylicostomum and less than 1 per cent. effective against strongylus. The horse was fasted less than twenty-four hours before treatment.

Horse No. 1033, a six-year-old gelding weighing 1075 lbs., was given 16 mils of chenopodium, followed immediately by a quart of linseed oil, the horse having been fasted a full twenty-four hours before treatment. The next day the animal passed 1 cylicostomum, the third day 30 cylicostomum and 30 strongylus, the fourth day 34 cylicostomum and 49 strongylus, and the fifth day 12 cylicostomum and 8 strongylus, a total of 77 cylicostomum and 107 strongylus. The animal was killed on the fifth day. On *post-mortem* examination there were found two larval cylicostomum that might have issued from a cyst in the œsophageal mucosa after the treatment, and probably did do this. Regarding them as having issued from their cysts after the passage of the anthelmintic, the treatment was 100 per cent. effective against cylicostomum and strongylus. Even regarding them as surviving the anthelmintic would make the treatment 97 per cent. effective against cylicostomum.

Horse No. 240, an eight-year-old gelding weighing 1100 lbs., was given 16 mils of oil of chenopodium followed two hours later by a quart of linseed oil. The next day the horse passed 352 cylicostomum and 1 strongylus, the second day 184 cylicostomum and 26 strongylus, the third day 4 cylicostomum and 22 strongylus, the fourth day 6 strongylus, and the fifth day 2 strongylus, a total of 540 cylicostomum and 61 strongylus. The horse was killed on the fifth day. On *post-mortem* examination, 2 dead strongylus were found in the floating colon and 3 dead strongylus in the double colon, which worms must be regarded as killed by the anthelmintic. There were also three live strongylus in the cæcum. The treatment was therefore 100 per cent, effective against cylicostomum and 96 per cent. effective against strongylus.

Horse No. 1031, an eight-year-old gelding weighing 1060 lbs., was given the iron sulphate treatment. The intention was to give doses of 4 grammes of iron sulphate twice daily in a mash, for a period of seven days, but as the horse refused to clean up this amount of medicated mash, the fourteen doses were administered over a period of twelve days. The manure was only casually examined for strongylus and cylicostomum, being primarily examined for ascarids. The third day of the treatment the horse passed 1 cylicostomum, the fifth day 2 cylicostomum, a total of 3 cylicostomum. Sixteen days after beginning treatment, the horse was given three doses of 6 mils of chenopodium at hour intervals, the last dose being followed an hour later by a quart of linseed oil. The horse was fasted over twenty-four hours. The day of treatment the horse passed 49 cylicostomum, the following day 1024 cylicostomum and 54 strongylus, the second day 103 cylicostomum and 11 strongylus, the third day 30 cylicostomum, the fourth day 35 cylicostomum and 6 strongylus, and the fifth day 1 cylicostomum and 5 strongylus, a total of 1242 cylicostomum and 76 strongylus. The horse was killed on this fifth day and found to have 2 larval cylicostomum, which we regard as having left their cysts in the intestinal mucosa after the anthelmintic had passed out, and 4 live strongylus in addition to the 2 dead strongylus passing out in the floating colon. The treatment was therefore 100 per cent. effective against cylicostomum and 95 per cent. effective against strongylus.

From the foregoing experiments we may come to the following conclusions:—

Iron sulphate in the light dose used (2 drachms in a mash daily for seven days) was a failure, removing no strongylus and less than 1 per cent. of the cylicostomum present. Not too much may be concluded in regard to the value of larger doses, but in view of the fact that this treatment is not recommended for strongyles, it is likely that it is not of much value. This conclusion is substantiated by the poor results obtained from the administration of 7 ozs. of iron sulphate over a period of twelve days in the case of horse No. 1031.

Tartar emetic in the light dose used (2 drachms in a mash daily for five days) was a failure, removing less than 1 per cent. of the strongyles present. The evidence of severe irritation in the digestive tract *post-mortem* inclines us to believe that this drug is not apt to prove of much value in this condition, as increased size of dose to secure greater efficacy would mean a degree of gastro-intestinal irritation that in our opinion should be avoided.

Turpentine in a moderate dose (2 ozs. in a quart of linseed oil) was a rather effective remedy in the one test made, removing all of the cylicostomum and 48 per cent. of the strongylus.

Oil of chenopodium was a failure in small doses with less than a twenty-four-hour fast, failing to remove 1 per cent. of the strongyles present in a dose of 8 mils; it was less than 1 per cent. effective against strongylus and only 29 per cent. effective against cylicostomum in a dose of 10 mils. In larger doses, with less than a twenty-four-hour fast before treatment, the findings are somewhat contradictory: a 16-mil dose was 100 per cent. effective against cylicostomum and 76 per cent. effective against strongylus, while an 18-mil dose was 11 per cent. effective against cylicostomum and less

than 1 per cent. effective against strongylus. In these same larger doses, with fasts of at least twenty-four hours, the treatment is highly effective. In one case, where the chenopodium and linseed oil were given simultaneously, the treatment was apparently 100 per cent. effective against strongyles; in another case, where the linseed oil was given two hours after the chenopodium, the treatment was 100 per cent. effective against cylicostomum and 96 per cent. effective against strongyles; in another case, where the chenopodium was given in divided doses followed by linseed oil an hour after the last dose, the treatment was 100 per cent. effective against cylicostomum and 95 per cent. against strongylus.

SUMMARY.

Contrary to what has been supposed, the removal of strongyles from the large intestine of the horse presents no great difficulties. The remedy of choice is oil of chenopodium, which displays an efficacy of 95 to 100 per cent. when given to horses fasted thirty-six hours and given in doses of 16 to 18 mils, in one dose or in divided doses, accompanied by a quart or a litre of linseed oil or followed one or two hours later by this amount of linseed oil. The small worms, cylicostomum, are more readily removed than the large, red palisade worms, strongylus, probably due to the fact that strongylus attaches to the mucosa and cylicostomum does not. Turpentine appears to be the second choice of the remedies tested. In the doses used, iron sulphate and tartar emetic gave very poor results and promised little of value in the treatment of strongylidosis.

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SCRAPIE.

By J. P. M'Gowan, M.A., M.D., B.Sc., M.R.C.P.E.

(From the Bacteriology Department, Johnston Laboratories, University of Liverpool.)

In the June number of the *Journal of Comparative Pathology and Therapeutics* of this year (p. 102) there appeared an article on "Scrapie" by Sir John M'Fadyean, in which, amongst other things,